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ARTICLE 230 - SERVICES

A. General Requirements

230-1. Scope. The provisions of this Article shall apply to the conductors and equipment for control and protection of services - circuits that conduct electric power from the supply system or plant to the premises to be served.

230-2. Number of Services to a Building or Other Premises Served.

In general, a building or other premises served shall be supplied through only one set of service conductors, except as follows:

230-21. Number of Drops. No building shall be supplied through more than one service drop, except for the purposes listed in Section 230-2.

230-22. Service Drop Conductors.

(a) In multiple conductor cables, conductors shall be insulated or covered with rubber or thermoplastic.

Exception. A grounded conductor may be without insulation or covering where the nominal voltage to ground of any conductor is not over 300 volts.

(b) All open, individual conductors shall be insulated or covered.

230.23. Minimum Size of Service Drop Conductors. Conductors shall have sufficient ampacity to carry the load. They shall have adequate mechanical strength and shall not be smaller than No. 8 copper or No. 6 aluminum.

Exception. For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than No. 12 hard drawn copper or equivalent.

Overhead conductors to a building or other structure from a pole on which a meter or disconnecting means is installed shall be considered as a service drop and installed accordingly.

Conductors having extruded covering used for service drops have the same ampacities as covered conductors listed in Tables 310-13 and 310-15.

230-24. Clearance of Service Drops. Service drop conductors shall not be readily accessible and when not in excess of 600 volts, shall conform to the following:

(a) Clearance Over Roof. Conductors shall have a clearance of not less than 8 ft. from the highest point of roofs over which they pass with the following exceptions:

Exception No. 1. Where the voltage between conductors does not exceed 300 and the roof has a slope of not less than 4 inches in 12 inches the clearance may be not less than 3 feet.

Exception No. 2. Service drop conductors of 300 volts or less which do not pass over other than a maximum of 4 feet of the overhang portion of the roof for the purpose of terminating at a (through-the-roof) service raceway or approved support may be maintained at a minimum of 18 inches from any portion of the roof over which they pass.

(b) Clearance from Ground. Service drop conductors when not in excess of 600 volts, shall have the following minimum clearance from ground.

10 feet -above finished grade, sidewalks or from any platform or projection from which they might be reached;

12 feet -over residential driveways and commercial areas such as parking lots and drive-in establishments not subject to truck traffic;

Exception No. 1. Fire Pumps. Where a separate service is required for fire pumps.

Exception No. 2. Emergency Lighting. Where a separate service is required for emergency lighting and power purposes.

Exception No. 3. Multiple-Occupancy Buildings.

(a) By special permission, in multiple-occupancy buildings where there is no available space for service equipment accessible to all the occupants.

(b) Buildings of multiple occupancy may have two or more separate sets of service-entrance conductors which are tapped from one service drop or lateral, or two or more sub-sets of service-

entrance conductors may be tapped from a single set of main service-entrance conductors.

DEFINITION: Sub-sets of service-entrance conductors are taps from main service conductors run to service equipment.

Exception No. 4. Capacity Requirements. Where capacity requirements make multiple services desirable.

Exception No. 5. Buildings of Large Area. By special permission, where more than one service is necessary due to the area over which a single building extends.

Exception No. 6. Different Characteristics or Classes of Use. Where additional services are required for different voltages, frequency, or phase, or different classes of use. Different classes of use could be because of needs for different characteristics, or because of rate schedule as in the case of controlled water heater service.

230-3. Supply to a Building from Another. The service conductors supplying each building or structure shall not pass through the inside of another building unless these buildings are under single occupancy or management. See Section 230-45.

B. Insulation and Size of Service Conductors

230-4. Insulation of Service Conductors. Service conductors shall normally withstand exposure to atmospheric and other conditions of use without detrimental leakage of current to adjacent conductors, objects, or the ground.

For Service Drops - See Section 230-22.

For Service Entrance Conductors - See Section 230-40.

For Underground Services - See Section 230-30.

230-5. Size of Service Conductors. Service conductors shall have adequate ampacity to safely conduct the current for the loads supplied without a temperature rise detrimental to the insulation or covering of the conductors, and shall have adequate mechanical strength.

Minimum sizes are given in the following references:

For Service Drops - Section 230-23.

For Service Entrance Conductors - Section 230-41.

For Underground Service Conductors - Section 230-31.

For Farmstead Service Conductors - See Section 220-4(m).

15 feet -over commercial areas, parking lots, agricultural or other areas subject to truck traffic;

18 feet -over public streets, alleys, roads and driveways on other than residential property.

(c) Clearance from Building Openings. Conductors shall have a clearance of not less than 36 inches from windows, doors, porches, fire escapes, or similar locations.

Conductors run above the top level of a window are considered out of reach from that window.

For clearances of conductors of over 600 volts see National Electrical Safety Code®. (Available from Superintendent of Documents, Government Printing Office, Washington, D.C. 20401.)

230-25. Supports Over Buildings. Where practicable, conductors passing over a building shall be supported on structures which are independent of the building. Where necessary to attach conductors to roof they shall be supported on substantial structures.

230-26. Point of Attachment. The point of attachment of a service drop to a building or other structure shall be not less than 10 feet above finished grade and shall be at a height to permit the minimum clearance requirements of Section 230-24.

In the event a mast type riser is required to attain the required height, it shall be of such construction and so supported that it will withstand the strain imposed by the service drop. Raceway fittings shall be of a type approved for the purpose.

230-27. Means of Attachment. Multiple-conductor cables used for service drops shall be attached to buildings or other structures by fittings approved for the purpose. Open conductors shall be attached to noncombustible, nonabsorptive insulators securely attached to the building or other structure or by fittings approved for the purpose.

D. Underground Services

230.30. Insulation - Underground Service Conductors.

(a) Underground conductors up to the point of connection to service equipment shall be insulated, except:

Exception No. 1. Where the nominal voltage to ground of any conductor is not over 300 volts, a grounded conductor of copper or aluminum without individual insulation or covering may be installed underground when part of an approved cable assembly.

Exception No. 2. Where the nominal voltage to ground of any conductor is not over 300 volts, bare grounded conductors of copper may be installed underground in duct or conduit.

(b) Insulated service conductors installed underground, or in concrete slabs or masonry in direct contact with earth, shall be lead-covered or of other types specially approved for the purpose.

230-31. Size of Underground Service Conductors.

(a) **Size of Underground Service Lateral.** Conductors shall have sufficient ampacity to carry the load. They shall not be smaller than No. 8, copper or No. 6 aluminum.

Exception: For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than No. 12 copper or No. 10 aluminum.

(b) **Size of Underground Service Entrance Conductors.** Same as required for overhead service entrance conductors. See Section 230-41.

(c) **Number of Service Laterals.** No building or other structure shall be supplied through more than one service lateral, except for the purposes listed in Section 230-2.

230-32. Protection Against Damage.

(a) **In the Ground.** Underground service conductors shall be protected against physical damage by being installed:

- (1) in duct,
- (2) in rigid metal conduit or electrical metallic tubing made of a material suitable for the condition, or provided with corrosion protection suitable for the condition;
- (3) in rigid nonmetallic conduit if installed in accordance with Sections 347-2 and 347-3;
- (4) in cable of one or more conductors approved for direct burial in the earth;
- (5) other approved means.

(b) **On Poles.** Where underground service conductors are carried up a pole the mechanical protection shall be installed to a point at least 8 feet above the ground. Such mechanical protection may be provided by the use of approved cable, pipe, or other approved means.

(c) **Where Entering Building.** Underground service conductors shall have mechanical protection in the form of rigid or flexible conduit, electrical metallic tubing, auxiliary gutters, the metal tape of an approved service cable, or other approved means. The mechanical protection shall extend to the enclosure for the service equipment unless the service switch is installed on a switchboard, in which case a bushing shall be provided which,

except where lead-covered conductors are used, shall be of the insulating type.

230-33. Raceway Seal. Where a service raceway or duct enters from an underground distribution system, the end within the building shall be sealed with suitable compound so as to prevent the entrance of moisture or gases. Spare or unused ducts shall also be sealed.

E. Service-Entrance Conductors

230-40. Insulation of Service-Entrance Conductors.

(a) Service-entrance conductors entering buildings or other structures shall be insulated. Where only on the exterior of buildings or other structures the conductors shall be insulated or covered.

Exception: Where the nominal voltage to ground of any conductor is not over 300 volts, a bare grounded conductor may be installed.

(b) Open individual conductors which enter the building or other structure shall be rubber-covered or thermoplastic-covered.

230-41. Size of Service-Entrance Conductors, Overhead System and Underground System. Service-entrance conductors shall have sufficient ampacity to carry the load as determined by Article 220 and in accordance with Tables 310-12, 310-13, 310-14, 310-15. Service entrance conductors shall not be smaller than No. 6 except:

Exception No. 1. For single family residences with an initial load of 10 KW or more computed in accordance with Article 220, or if the initial installation has more than five 2-wire branch circuits, the service-entrance conductors shall have an ampacity of not less than 100 amperes 3-wire.

It is recommended that a minimum of 100 ampere 3-wire service be provided for all individual residences.

Exception No. 2. For installations consisting of not more than two 2-wire branch circuits they shall not be smaller than #8.

Exception No. 3. By special permission due to limitations of supply source or load requirements they shall not be smaller than No. 8.

Exception No. 4. For installations to supply only limited loads of a single branch circuit, such as small polyphase power, controlled water heaters and the like, they shall not be smaller than the conductors of the branch circuit and in no case smaller than No. 12.

Exception No. 5. The neutral conductor which shall have an ampacity in conformity with Section 220-4(d), but shall not be smaller than the ungrounded conductors when these are No. 8 or smaller.

230-42. Service-Entrance Conductors without Splice. Service-entrance conductors shall be without splice except as follows:

Exception No. 1. Clamped or bolted connections in a meter enclosure are permitted.

Exception No. 2. Taps to main service conductors are permitted as provided in Section 230-2 Exception No. 3(b) or to individual sets of service equipment as provided in Section 230-70(g).

Exception No. 3. A connection is permitted, when properly enclosed, where an underground service conductor enters a building and is to be extended to the service equipment or meter in another form of approved service raceway or service cable.

Exception No. 4. A connection is permitted where service conductors are extended from a service drop to an outside meter location and returned to connect to the service-entrance conductors of an existing installation.

230-43. Other Conductors in Service Raceway. Conductors other than service conductors, grounding conductors, or control conductors from time switches having overcurrent protection, shall not be installed in the same service raceway or service entrance cable.

F. Installation of Service-Entrance Conductors

230-44. Wiring Methods. Service-entrance conductors extending along the exterior, or entering buildings or other structures may be installed as follows:

(a) As separate conductors, in cables approved for the purpose, or enclosed in rigid conduit;

(b) For circuits not exceeding 600 volts the conductors may be installed in electrical metallic tubing, wireways, auxiliary gutters, busways or as a cablebus installed for services in accordance with Article 365.

Service-entrance conductors should not be run within the hollow spaces of frame buildings unless provided with overcurrent protection at their outer end.

230-45. Conductor Considered Outside Building. Conductors placed under at least two inches of concrete beneath a building, or conductors within a building in conduit or duct and enclosed by concrete or brick not less than two inches thick shall be considered outside the building.

230-46. Mechanical Protection. Individual open conductors or cables other than approved service-entrance cables, shall not be installed within 8 feet of the ground or where exposed to physical damage. Service-entrance cables, where liable to contact with awnings, shutters, swinging signs, installed in exposed places in

driveways, near coal chutes or otherwise exposed to physical damage, shall be of the protected type or be protected by conduit, electrical metallic tubing or other approved means.

230-47. Individual Open Conductors Exposed to Weather.

Individual open conductors exposed to weather shall be supported on insulators, racks, brackets, or other means, placed at intervals not exceeding 9 feet and separating the conductors at least 6 inches from each other and 2 inches from the surface wired over; or at intervals not exceeding 15 feet if they maintain the conductors at least 12 inches apart. For 300 volts or less, conductors may have a separation of not less than 3 inches where supports are placed at intervals not exceeding 4 1/2 feet and conductors are not less than 2 inches from the surface wired over.

230-48. Individual Open Conductors Not Exposed to Weather.

Individual open conductors not exposed to the weather may be supported on glass or porcelain knobs placed at intervals not exceeding 4 1/2 feet and maintaining the conductors at least one inch from the surface wired over and a separation of at least 2 1.2 inches between conductors.

230-49. Individual Conductors Entering Buildings. Individual conductors entering buildings shall pass inward and upward through slanting noncombustible, nonabsorptive insulating tubes, or shall enter through roof bushings, and shall conform to the provisions of Article 324. Drip loops shall be formed on the conductors before entering tubes.

230-50. Service Cables. Service cables of a type not approved for mounting in contact with a building shall have insulating supports at intervals not exceeding 15 feet, and maintaining a distance of at least 2 inches from the surface wired over. Service cables mounted in contact with the building shall be supported at intervals not exceeding 4 1/2 feet.

230-51. Connections at Service Head.

(a) Service raceways shall be equipped with a raintight service head.

(b) Service cables, unless continuous from pole to service equipment or meter, shall be either:

(1) equipped with a raintight service head or

(2) formed in a gooseneck, taped and painted or taped with a self-sealing weather-resistant thermoplastic.

(c) Service heads and goosenecks in service-entrance cables shall be located above the point of attachment of the service-drop conductors to the building or other structure.

Exception: Where it is impracticable to locate the service head above the point of attachment, the service head may be located not farther than twenty-four inches from the point of attachment.

(d) Service cables shall be held securely in place by connection to service-drop conductors below the gooseneck or by a fitting approved for the purpose.

(e) Service heads shall have conductors of opposite polarity brought out through separately bushed holes.

(f) Drip loops shall be formed on individual conductors. To prevent the entrance of moisture, service-entrance conductors shall be connected to the service-drop conductors either:

(1) below the level of the service head, or

(2) below the level of the termination of the service-entrance cable sheath.

(g) Service-drop conductors and service-entrance conductors shall be so arranged that water will not enter service raceway or equipment.

230-52. Enclosing Raceways Made Raintight. When rigid metal raceways are installed where exposed to weather the raceways shall be made raintight and arranged to drain.

230-53. Terminating Raceway at Service Equipment. Where conduit, electrical metallic tubing, or service cable is used for service conductors, the inner end shall enter a terminal box or cabinet, or be made up directly to an equivalent fitting, enclosing all live metal parts, except that where the service disconnecting means is mounted on a switchboard having exposed bus-bars on the back, the raceway may be equipped with a bushing which shall be of the insulating type unless lead-covered conductors are used.

G. Service Equipment

230-60. Hazardous Locations. Service equipment installed in hazardous locations shall comply with the requirements of Articles 500 517 inclusive.

230-61. Service Equipment Grouped. Where supplied at the same side of the building by more than one overhead service drop or more than one set of underground service conductors, the service equipment, except for services as permitted in Section 230-2, shall be grouped and equipment marked to indicate the load it serves.

H. Grounding and Guarding

230-62. Guarding. Live parts of service equipment shall be enclosed so that they will not be exposed to accidental contact, unless mounted on a switchboard, panel or controller accessible to qualified persons only and located in a room or enclosure free from easily ignitable material. Such an enclosure shall be provided with means for locking or sealing doors giving access to live parts.

230-63. Grounding and Bonding. Service equipment shall be grounded as follows:

(a) **Equipment.** The enclosure for service equipment shall be grounded in the manner specified in Article 250, unless (1) the voltage does not exceed 150 volts to ground and such enclosures are (2) isolated from conducting surfaces, and (3) unexposed to contact by persons or materials that may also be in contact with other conducting surfaces.

(b) **Raceways and Cable Armor.** Service raceways, cable armor and the metal sheath of service cables, shall be grounded. Conduit and metal pipe from underground supply shall be considered sufficiently grounded where containing lead-sheathed cable bonded to a continuous underground lead-sheathed cable system.

(c) **Flexible Conduit.** Where a service run of rigid metal raceway is interrupted by flexible metal conduit, the sections of rigid metal raceway thus interrupted shall be bonded together by a copper conductor not smaller than specified for grounding conductors in Table 250-94(a), using clamps or other approved means. The conductor and bonding devices shall be protected from physical damage. Where the flexible conduit runs to the service cabinet, similar bonding shall be installed between the cabinet and the rigid raceway.

J. Disconnecting Means

230-70. General.

(a) **Disconnection from Service Conductors.** Means shall be provided for disconnecting all conductors in the building or other structure from the service entrance conductors.

(b) **Location.** The disconnecting means shall be located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building or structure. Sufficient access and working space shall be provided about the disconnecting means.

In a multiple occupancy building, each occupant shall have access to his disconnecting means. A multiple occupancy building having individual occupancy above the second floor shall have service equipment grouped in a common accessible place, the disconnecting means consisting of not more than six switches or

six circuit breakers. Multiple occupancy buildings that do not have individual occupancy above the second floor may have service conductors run to each occupancy in accordance with Section 230-2, Exception No. 3 and each such service may have not more than six switches or circuit breakers.

(c) Approval. The disconnecting means shall be of a type approved for service equipment and for prevailing conditions.

(d) Types Permitted. The disconnecting means for ungrounded conductors shall consist of either:

(1) A manually operable switch or circuit breaker equipped with a handle or other suitable operating means positively identified and marked for mechanical operation by hand.

(2) An electrically operated switch or circuit breaker provided the switch or circuit breaker can be opened by hand in event of a failure of the power supply and the open and closed positions are clearly indicated to the operator.

(e) Externally Operable. An enclosed service switch or circuit breaker shall be extremely operable.

(f) Indicating. The disconnecting means shall plainly indicate whether it is in the open or closed position.

(g) Switch and Circuit Breaker. The disconnecting means for each set or sub-set of service-entrance conductors shall consist of not more than six switches or six circuit breakers in a common enclosure, or group of separate enclosures. Two or three single pole switches or breakers, capable of individual operation, may be installed on multiwire circuits, one pole for each ungrounded conductor, as one multipole disconnect provided they are equipped with "handle ties," "handles within 1/16 inch proximity," a "master handle," or "other means," making it practical to disconnect all conductors of the service with no more than six operations of the hand.

See Section 384-16(a).

(h) Simultaneous Openings. The disconnecting means shall simultaneously disconnect all ungrounded conductors, except for 3-wire direct-current or single-phase circuits or multiwire circuits that do not supply polyphase motors.

See Section 200-5(a).

(i) Disconnection of Grounded Conductor. Where the switch or circuit breaker does not interrupt the grounded conductor, other means shall be provided in the service cabinet or on the switchboard for disconnecting the grounded conductor from the interior wiring.

230.71. Rating of Service Equipment.

(a) The service equipment shall have a rating not less than the load to be carried determined in accordance with Article 220.

The service disconnecting means shall have a rating of not less than 60 amperes 1 except:

Exception No. 1. For single family residences with an initial load of 10 KW or more computed in accordance with Article 220, or if the initial installation has more than five 2-wire branch circuits, the service equipment shall have a rating of not less than 100 amperes 3-wire.

Exception No. 2. For installations consisting of not more than two 2-wire branch circuits a service equipment of 30-ampere minimum rating may be used.

(b) Where multiple switches or circuit breakers are used in accordance with Section 230-70(g) the combined rating shall not be less than required for a single switch or breaker.

230-72. Connection to Terminals. The service conductors shall be attached to the disconnecting means by pressure connectors, clamps or other approved means, except that connections which depend upon solder shall not be used.

230-73. Connections Ahead of Disconnecting Means. The following may be connected ahead of the service disconnecting means:

(a) Service fuses, high-impedance shunt circuits, time switches, surge protective capacitors, instrument transformers (current and potential) and lightning arresters.

(b) Taps used only to supply time switches, circuits for emergency systems, fire pump equipment, fire and sprinkler alarms if provided with service equipment and installed in accordance with requirements for service-entrance conductors.

(c) Meters nominally rated not in excess of 600 volts, provided all metal housings and service enclosures are grounded in accordance with Article 250.

For detailed service provisions for fire alarm, sprinkler supervisory, or watchman systems, see appropriate Standards of the National Fire Protection Association.

230-74. Safeguarding Emergency Supply. Where an emergency supply is provided to feed the conductors controlled by the service disconnecting means, the disconnecter shall be of a design that will open all ungrounded conductors from the usual supply before connection is made to the emergency supply, unless agreed upon arrangements have been made for parallel operation and suitable automatic control equipment provided. See Article 700.

230-76. More than One Building. In a property comprising more than one building under single management, the conductors supplying each building served shall be provided with a readily accessible means, within an adjacent to the building, of disconnecting all ungrounded conductors from the source of supply. In garages and outbuildings on residential property the disconnecting means may consist of a snap switch, suitable for use on branch circuits, including switch controls at more than one point.

K. Overcurrent Protection

230-90. Where Required. Each ungrounded service-entrance conductor shall have overcurrent protection.

(a) Ungrounded Conductor. Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor, having a rating or setting not higher than the allowable ampacity of the conductor, except as follows:

Exception No. 1. For motor-starting currents, ratings in conformity with Sections 430-52, 430-62, or 430-63 may be used.

Exception No. 2. Fuses and circuit breakers may have a rating or setting in conformity with Section 240-5(a), Exceptions No. 1 and 2, also Section 240-5(b).

Exception No. 3. Not more than six circuit breakers or six sets of fuses may serve as the overcurrent device.

Exception No. 4. In a multiple occupancy building each occupant shall have access to his overcurrent protective devices.

A multiple occupancy building having individual occupancy above the second floor shall have service equipment grouped in a common accessible place, the overcurrent protection consisting of not more than six circuit breakers or six sets of fuses. Multiple occupancy buildings that do not have individual occupancy above the second floor may have service conductors run to each occupancy and each such service may have not more than six circuit breakers or six sets of fuses.

A set of fuses is all the fuses required to protect all the ungrounded conductors of a circuit. Single pole breakers may be grouped as in Section 230-70(g) as one multiple protective device.

(b) Not in Grounded Conductor. No overcurrent device shall be inserted in a grounded service conductor except a circuit breaker which simultaneously opens all conductors of the circuit.

(c) More Than One Building. In a property comprising more than one building under single management, the ungrounded conductors supplying each building served shall be protected by overcurrent devices, which may be located in the building served

or in another building on the same property, provided they are accessible to the occupants of the building served.

230-91. Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent there to, unless located at the outer end of the entrance.

230-92. Location of Branch-Circuit Overcurrent Devices. Where the service overcurrent devices are locked or sealed, or otherwise not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in an accessible location and shall be of lower rating than the service overcurrent device.

230-93. Protection of Specific Circuits. Where necessary to prevent tampering, an automatic overcurrent device protecting service conductors supplying only a specific load such as a water heater, may be locked or sealed where located so as to be accessible.

230-94. Relative Location of Overcurrent Device and Other Service Equipment. The overcurrent device shall protect all circuit and devices except as follows:

(a) The service switch may be placed on the supply side.

(b) High impedance shunt circuits, lightning arresters, surge protective capacitors, instrument transformers, (current and potential), may be connected and installed on the supply side of the service disconnecting means as permitted in Section 230-73.

(c) Circuits for emergency supply and time switches may be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

(d) Circuits used only for the operation of fire alarm, other protective signalling systems, or the supply to fire pump equipment may be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

(e) Meters nominally rated not in excess of 600 volts, provided all metal housings and service enclosures are grounded in accordance with Article 250.

L. Services Exceeding 600 Volts

230-100. Scope. Service conductors and equipment used on circuits exceeding 600 volts shall comply with the applicable provisions of the preceding Sections of this Article and with the following Sections which are additions to or modifications of the preceding Sections.

Secondary conductors, not the primary conductors, are the service conductors to the building proper in the following cases:

1. Where step-down transformers are located outdoors.
2. Where step-down transformers are located in a separate building from the one served.
3. Where step-down transformers are located in the building served in transformer vaults locked rooms or locked enclosures in accordance with Article 450 and accessible only to qualified persons.

In all other cases, the primary conductors are the service conductors.

In no case will the provisions of this Article apply to equipment connected ahead of the service conductors.

230-101. Service-Entrance Conductors.

(a) **Conductor Size.** Service conductors shall be not smaller than No. 6 unless in cable. Conductors in cable shall be not smaller than No. 8.

(b) **Wiring Methods.** In locations accessible to other than qualified persons service-entrance conductors of more than 600 volts shall be installed in rigid conduit, or as multiple conductor cable approved for the purpose.

(c) **Open Work.** If open work is employed where not accessible to other than qualified persons, the service conductors shall be rigidly supported on glass, porcelain or other insulators approved for the purpose, which will keep them at least 8 inches apart, except at terminals of equipment. They shall be not less than 2 inches from the surfaces wired over and for voltages exceeding 2,500 not less than 3 inches.

(d) **Supports.** Service conductors and their supports, including insulators, shall have strength and stability sufficient to insure maintenance of adequate clearance with abnormal currents in case of short circuits.

(e) **Guarding.** Open wires shall be guarded where accessible to unqualified persons.

(f) **Service Cable.** Where cable conductors emerge from a metal sheath or raceway, the insulation of the conductors shall be protected from moisture and physical damage by a pothead or other approved means.

(g) Draining Raceways. Unless conductors specifically approved for the purpose are used, raceways embedded in masonry, or exposed to the weather, or in wet locations shall be arranged to drain.

(h) Over 15,000 Volts. Where the voltage exceeds 15,000 volts between conductors they shall enter either metal enclosed switchgear or a transformer vault conforming to the requirements of Section 450-41 to 450-48.

(i) Conductor Considered Outside Building. Conductors placed under at least two inches of concrete beneath a building, or conductors within a building in conduit or duct and enclosed by concrete or brick not less than two inches thick shall be considered outside the building.

230.102. Warning Signs. High voltage signs shall be posted where unauthorized persons might come in contact with live parts.

230.103. Disconnecting Means. The circuit-breaker or the alternatives for it specified in Section 230-106 will constitute the disconnecting means required by Section 230-70 and shall comply with Section 230-70(h). The disconnecting means shall be capable of being closed on a fault within the maximum interrupting rating of the overcurrent protection.

230-104. Isolating Switches. Isolating switches shall be provided as follows:

(a) Air-break isolating switches shall be installed between oil switches or air or oil circuit breakers used as service switches and the supply conductor, except where such equipment is mounted on removable truck panels or metal-enclosed switchgear units which cannot be opened unless the circuit is disconnected, and which, when removed from the normal operating position, automatically disconnect the circuit breaker or switch from all live parts.

(b) When the fuses used with nonautomatic oil switches in accordance with Section 230-106 are of a type that may be operated as a disconnect switch, they may serve as the isolating switch when they completely disconnect the oil switch and all service equipment from the source of supply.

(c) Air-break isolating switches shall be accessible to qualified attendants only. They shall be arranged so that a grounding connection on the load side can readily be made. Such grounding means need not be provided for duplicate isolating switches, if any, installed and maintained by the supply company.

230-105. Equipment in Secondaries. Where the primary service equipment supplies one or more transformers whose secondary windings connect to a single set of mains, and the primary load-interrupter switch or circuit-breaker is capable of being opened and closed from a point outside the transformer vault, the disconnecting means and overcurrent protection may be omitted from the secondary circuit provided the primary fuse or circuit-breaker is rated or set to protect the secondary circuit.

230-106. Overcurrent Protection. Overcurrent devices shall be provided in accordance with the following:

(a) In Vault or Consisting of Metal-Enclosed Switchgear. Where the service equipment is installed in a transformer vault meeting the provisions of Sections 450-41 to 450-48, or consists of metal-enclosed switchgear, the requirements for overcurrent protection and disconnecting means may be fulfilled by the following:

(1) A non-automatic oil switch, oil fuse cutout, air load-interrupter switch, or other approved switch, capable of interrupting the rated circuit load, and suitable fuses may be used.

(2) An automatic trip circuit-breaker of suitable current carrying and interrupting capacity with an overcurrent unit in each ungrounded conductor may be used.

(3) A switch capable of interrupting the no-load current of the transformer supplied through the switch and suitable fuses may be used, provided the switch is interlocked with a single switch or circuit breaker on the secondary circuit of the transformer so that the primary switch cannot be opened when the secondary circuit is closed.

(4) A metal-enclosed switchgear shall consist of a substantial metal structure and a sheet metal enclosure. Barriers between adjacent switchgear units and internal metal barriers shall be not less than 1/8 inch of metal or No. 11 USS gage. All other covers, panels and doors shall be not less than No. 14 USS gage. Where installed over a wood floor, suitable protection thereto shall be provided.

(b) Not in Vault or Not Consisting of Metal-enclosed Switchgear. Where the service equipment is not in a vault or metal-enclosed switchgear, the requirements for the overcurrent protection and disconnecting means may be fulfilled by the following:

(1) Air load-interrupter switches, or other approved switches, capable of interrupting the rated circuit load may be used with suitable fuses on a pole or elevated structure outside the building provided the switch may be operated by persons using the building.

(2) On circuits of any voltage, an automatic trip circuit-breaker of suitable ampacity and interrupting capacity with an overcurrent unit in each ungrounded conductor may be used.

The circuit-breaker shall be located outside the building as near as practicable to where the service conductors enter the building.

The location may be on a pole, roof, foundation, or other structure.

(c) Fuses. Fuses shall have an interrupting rating at least equal to the maximum short-circuit current possible in the circuit.

(d) Circuit Breakers. Circuit breakers shall be free to open in case the circuit is closed on an overload. This can be accomplished by means such as trip-free breakers or by multiple breakers having an operating handle per pole. A service circuit breaker shall indicate clearly whether it is open or closed, and shall be capable of interrupting the maximum short-circuit current to which it may be subjected.

(e) Enclosed Overcurrent Devices. The restriction to 80 per cent of rating for an enclosed overcurrent device on continuous loads shall not apply to overcurrent devices installed in service operating at over 600 volts.

230-107. Lightning Arresters. Lightning arresters installed in accordance with the requirements of Article 280 shall be placed on each ungrounded overhead service conductor on the supply side of the service equipment, when called for by the authority having jurisdiction.